

FIG. 1

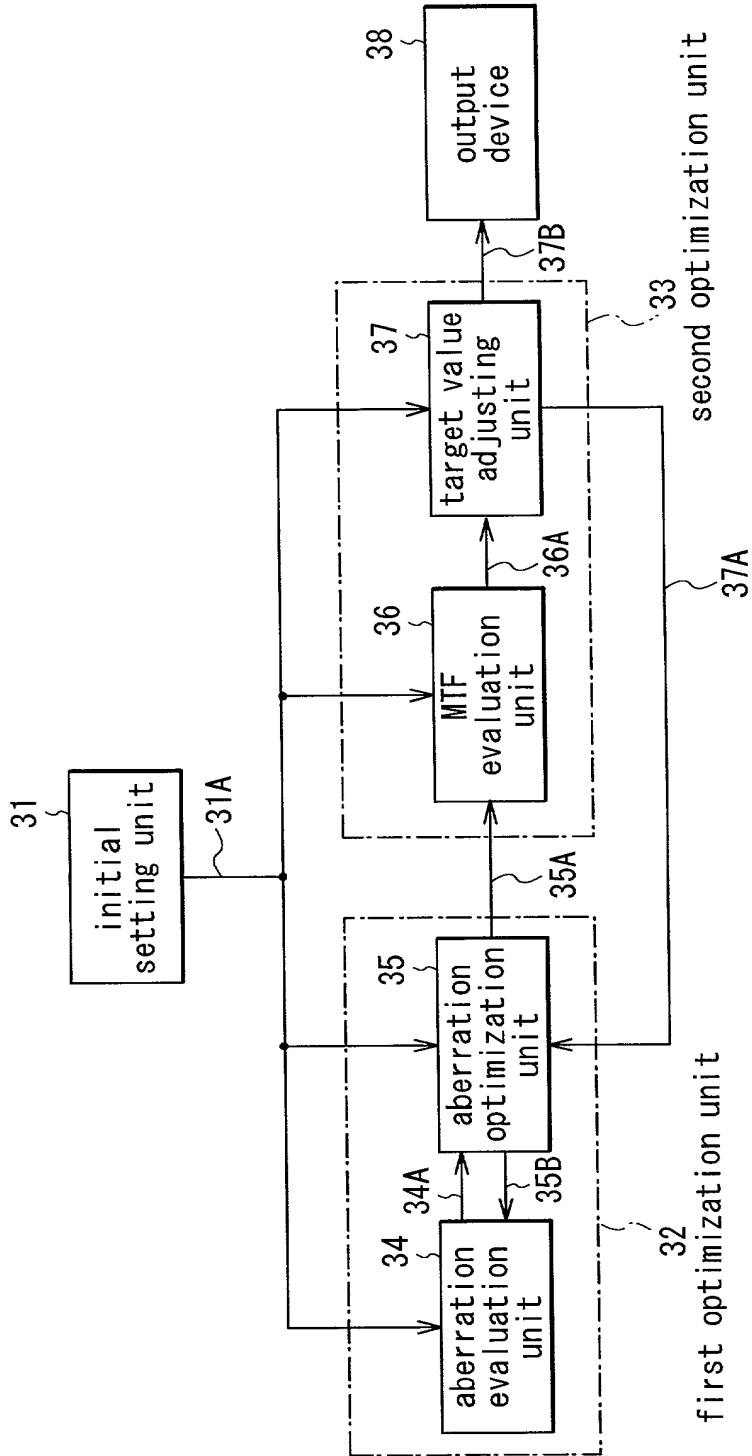


FIG. 2

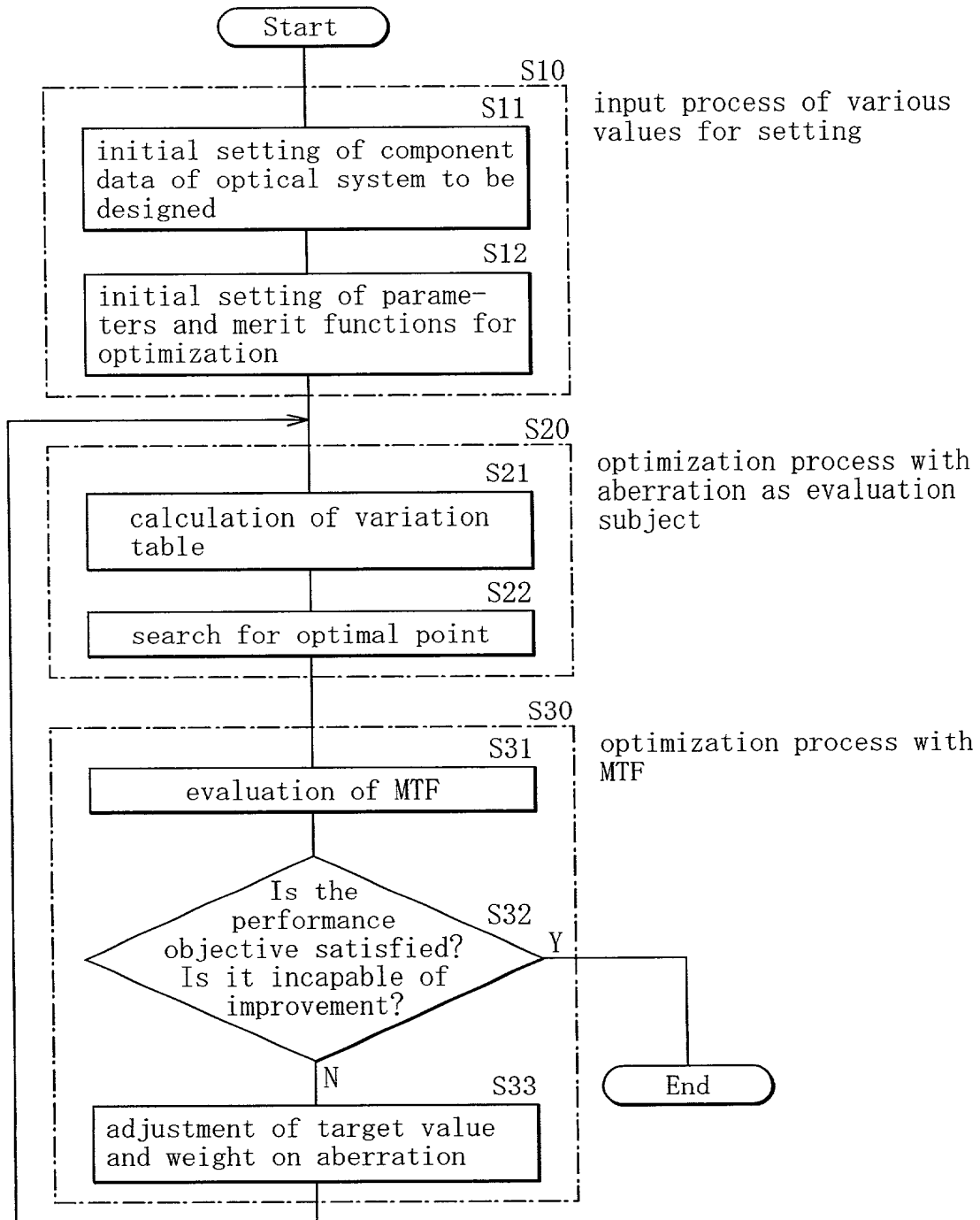


FIG. 3

US 2010/0100000 A1

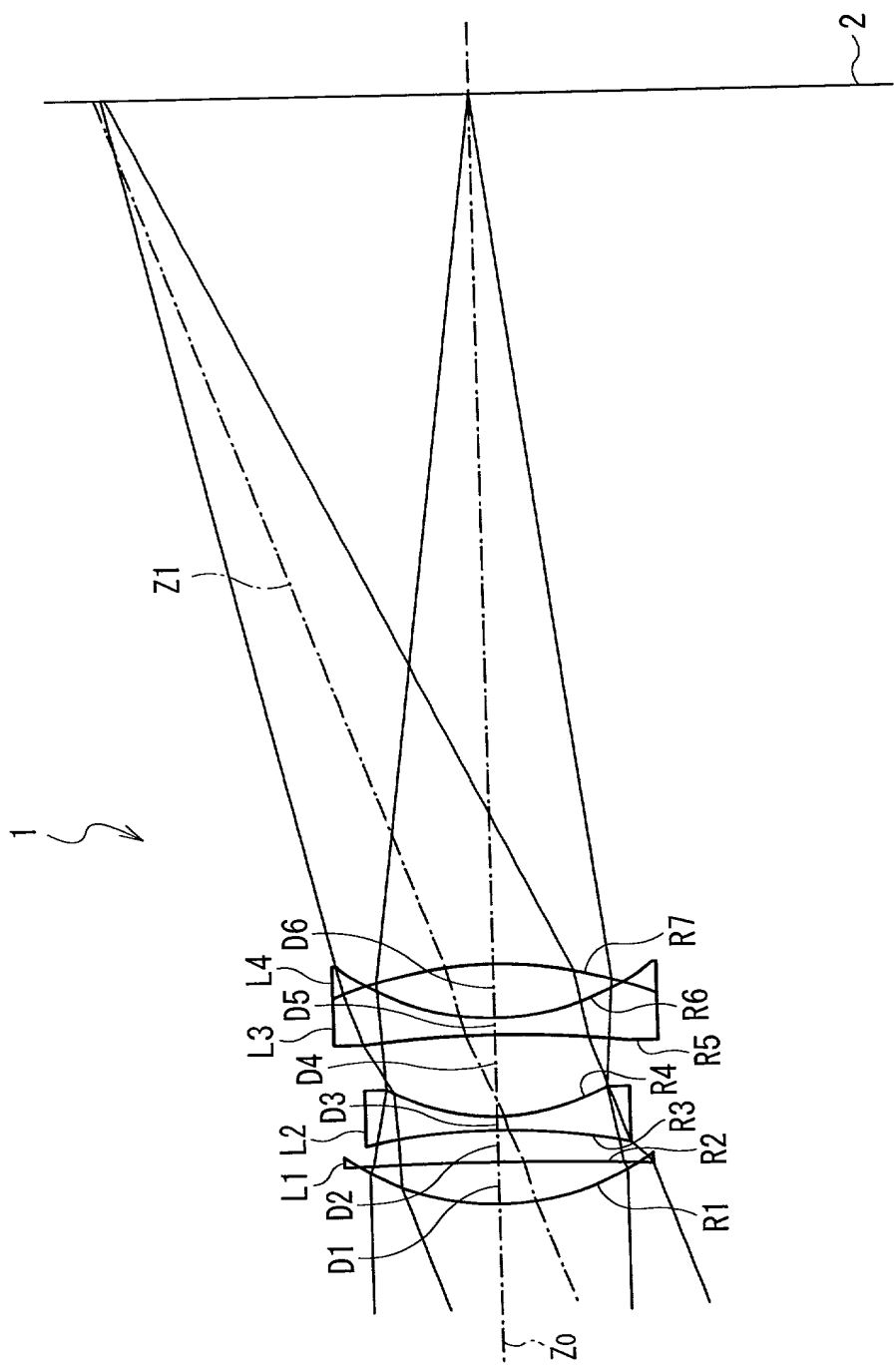


FIG. 4

Lens data at starting point				
S i (Surface No.)	R i (Radius of curvature)	D i (Surface separation)	N d i (Refractive index)	ν d i (Abbe's No.)
1	13.1502	2.0817	1.60800	56.5
2	-128.4561	1.4724		
3	-30.7685	0.8631	1.56000	45.3
4	11.9825	4.0111		
5	-73.1134	0.8631	1.56000	45.3
6	12.6425	2.5894	1.61600	55.0
7	-20.0046	0.0000		

FIG. 5

Design condition	
Focal length f	50mm
$F_{no.}$	4.0
Location of object point	infinite
Half field angle ω	20°
Sample object point	center, half field angle of 14° , half field angle of 20°
Evaluation frequency for MTF	40cs/mm
Sample wavelength	435.8nm, 546.1nm, 656.3nm
Weight for wavelength	1 , 1 , 1
Distortion	within 1%
Vignetting	none

FIG. 6

Target value for MTF				
Field angle	Target 1		Target 2	
	S direction	T direction	S direction	T direction
Center	65%		57%	
14°	55%	65%	57%	65%
20°	55%	65%	57%	65%

FIG. 7

Result with Target 1						
Field angle	M T F		Adjustment ratio of weight		Target value for mean of longitudinal aberrations (μm)	
	S direction	T direction	S direction	T direction	S direction	T direction
Center	64%		1.2		13.6	
14°	55%	64%	1.5	1.1	11.7	-12.4
20°	54%	64%	0.7	1.8	-11.6	-34.2

FIG. 8

Result with Target 2						
Field angle	M T F		Adjustment ratio of weight		Target value for mean of longitudinal aberrations (μm)	
	S direction	T direction	S direction	T direction	S direction	T direction
Center	56%		1.0		15.3	
14°	57%	65%	1.5	0.9	16.0	-10.7
20°	57%	64%	0.8	1.5	-10.8	-34.0

FIG. 9

Lens data of solution with Target 1				
S i (Surface No.)	R i (Radius of curvature)	D i (Surface separation)	N d i (Refractive index)	ν d i (Abbe's No.)
1	18.9178	5.9592	1.79080	48.9
2	48.4813	2.0454		
3	-56.2882	2.0000	1.66405	32.6
4	17.1377	2.3758		
5	120.5964	2.0710	1.57937	40.1
6	20.0136	3.8850	1.80000	48.0
7	-34.3802	0.0000		

FIG. 10

Lens data of solution with Target 2				
S i (Surface No.)	R i (Radius of curvature)	D i (Surface separation)	N d i (Refractive index)	ν d i (Abbe's No.)
1	18.4608	4.5462	1.80000	48.0
2	59.1162	2.3640		
3	-69.4418	2.0000	1.67159	32.1
4	16.3997	2.8414		
5	294.9039	2.2763	1.57555	40.8
6	20.8082	3.9552	1.80000	48.0
7	-35.6773	0.0000		

FIG. 11

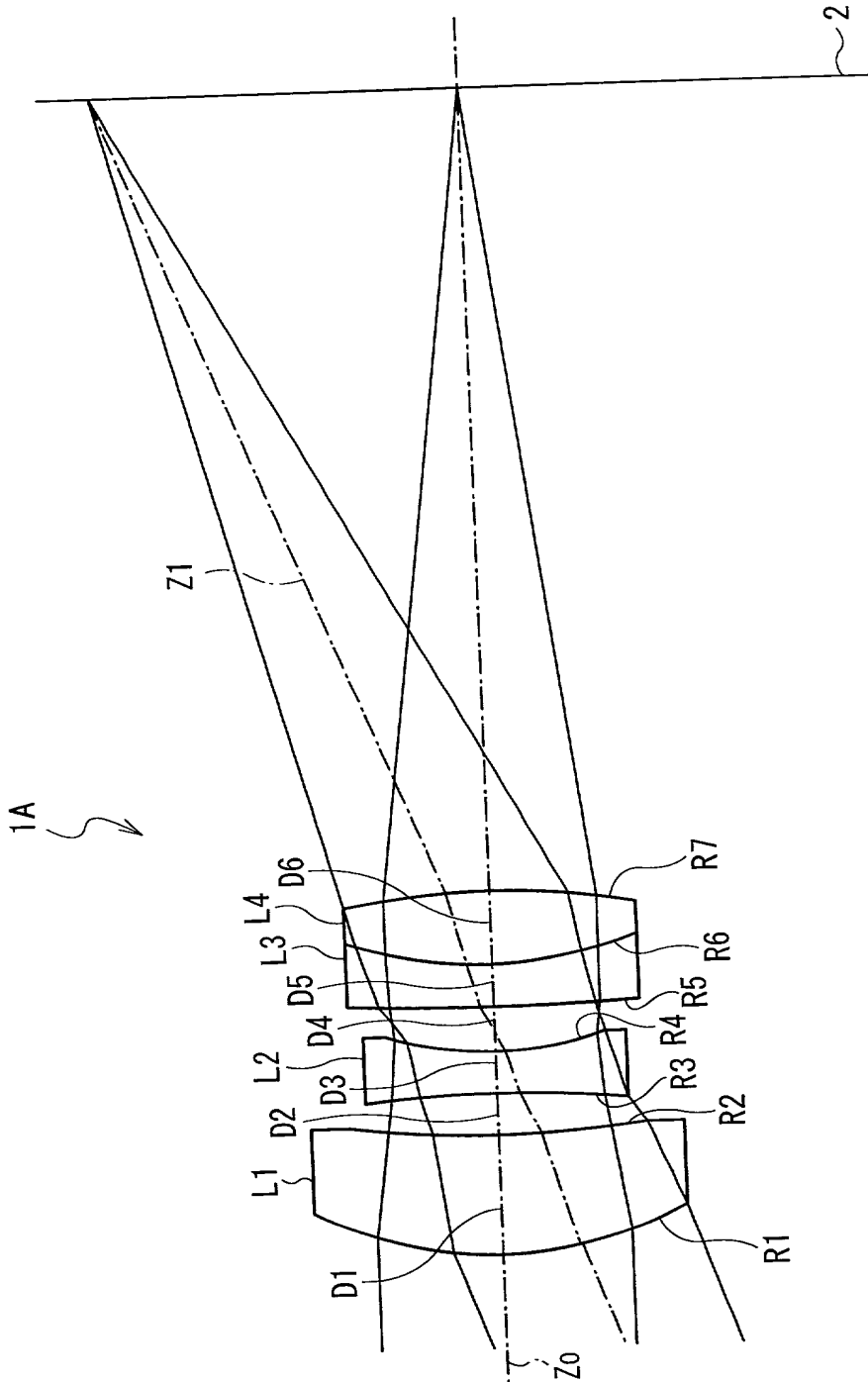


FIG. 12

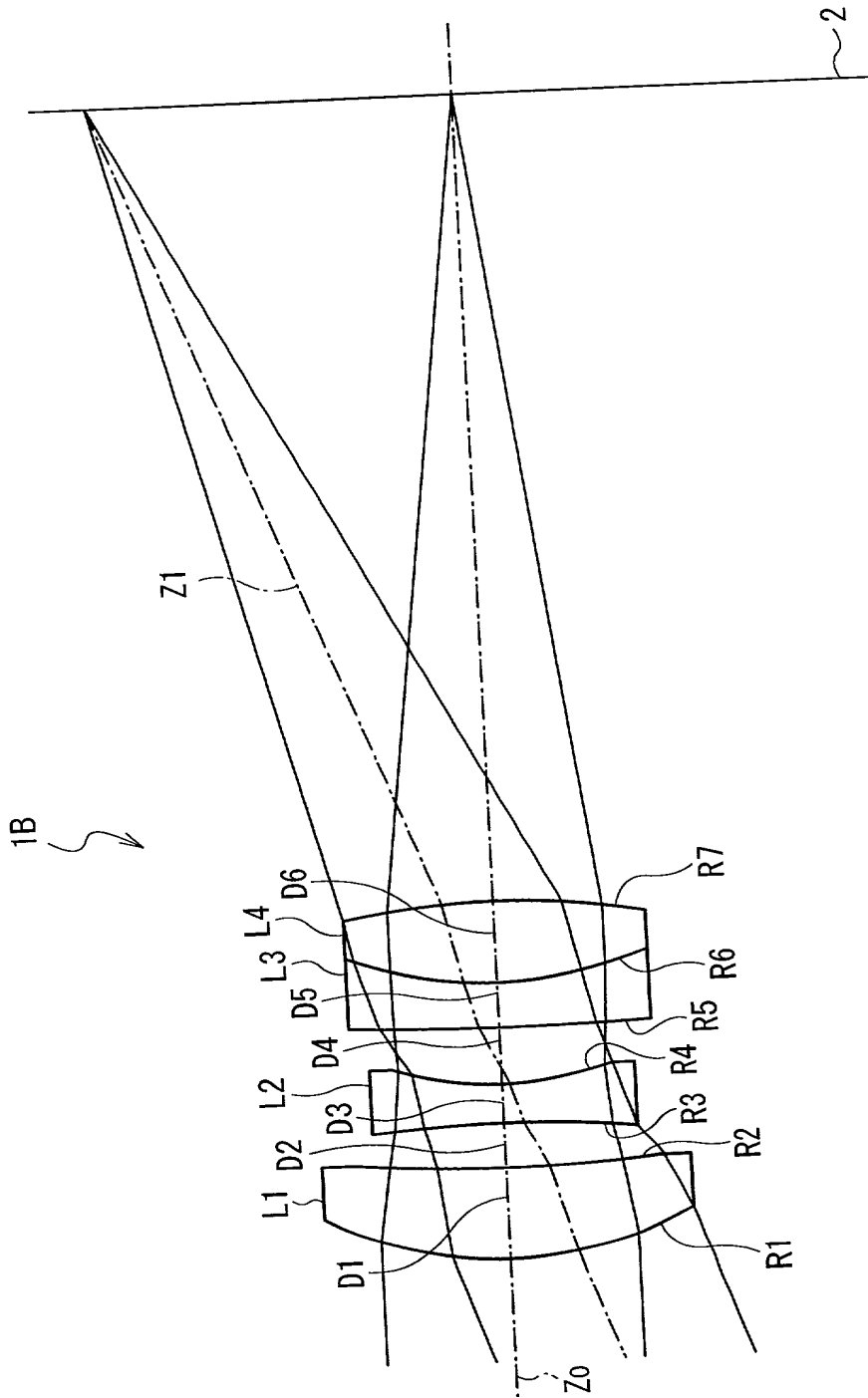


FIG. 13

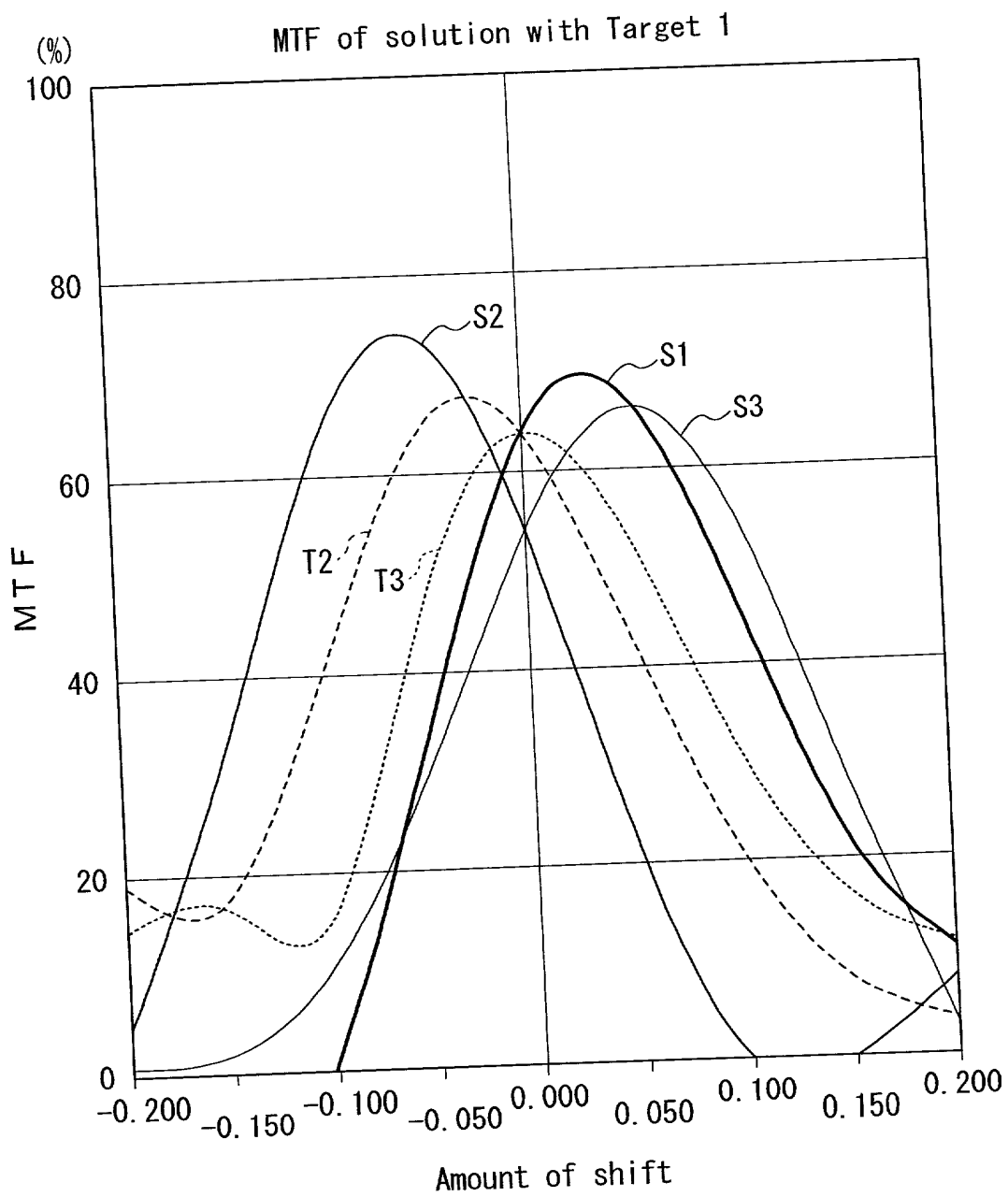


FIG. 14

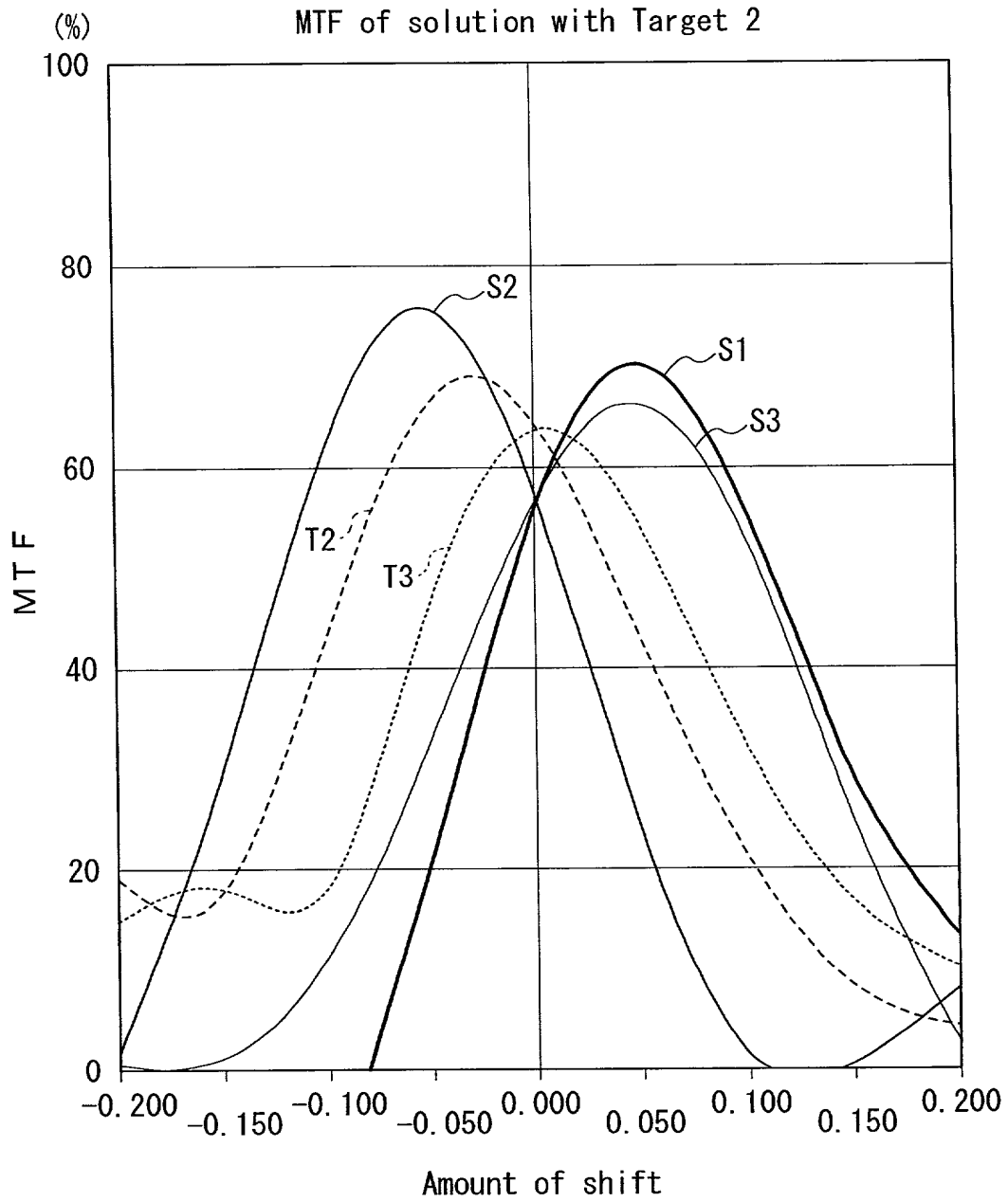


FIG. 15

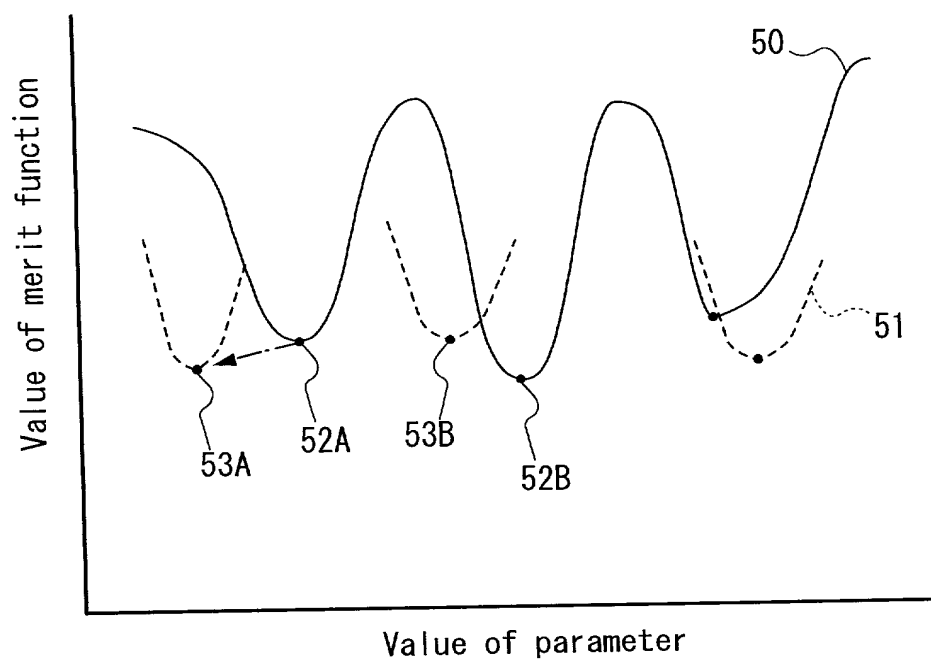


FIG. 16

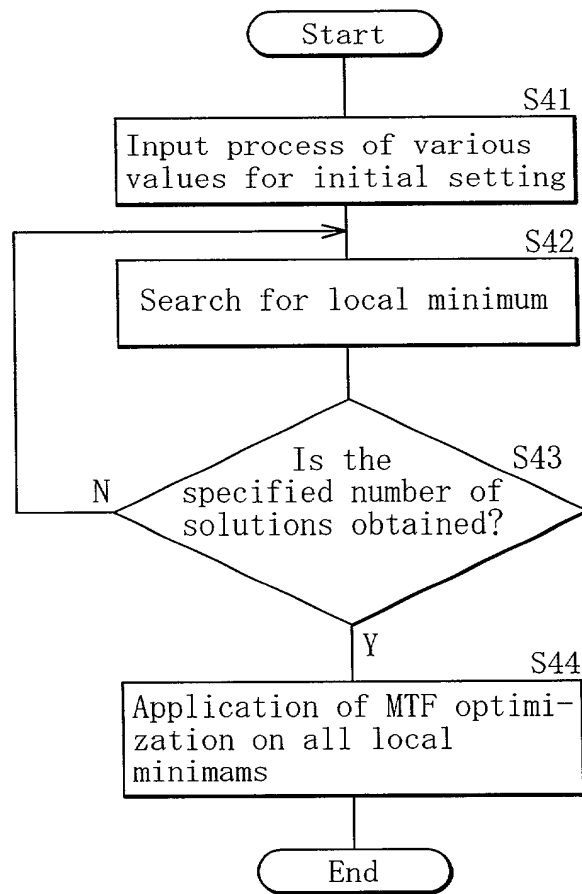


FIG. 17

Target value for MTF		
Field angle	Target	
	S direction	T direction
Center	65%	
14°	55%	65%
20°	60%	65%

FIG. 18

Solution No.	Value of merit function	
	Aberration	M T F
1	0.001598	10.3%
2	0.001543	10.7%
3	0.001539	2.7%
4	0.001549	7.7%
5	0.001539	6.5%

FIG. 19

Lens data of solution No.3				
S i (Surface No.)	R i (Radius of curvature)	D i (Surface separation)	N d i (Refractive index)	ν d i (Abbe's No.)
1	19.8762	5.4071	1.80000	43.8
2	-282.4339	1.6230		
3	-43.4813	2.0000	1.72558	30.2
4	16.8887	3.6591		
5	-127.0678	2.0000	1.67193	44.0
6	19.2644	5.2366	1.80000	48.0
7	-28.2142	0.0000		

FIG. 20

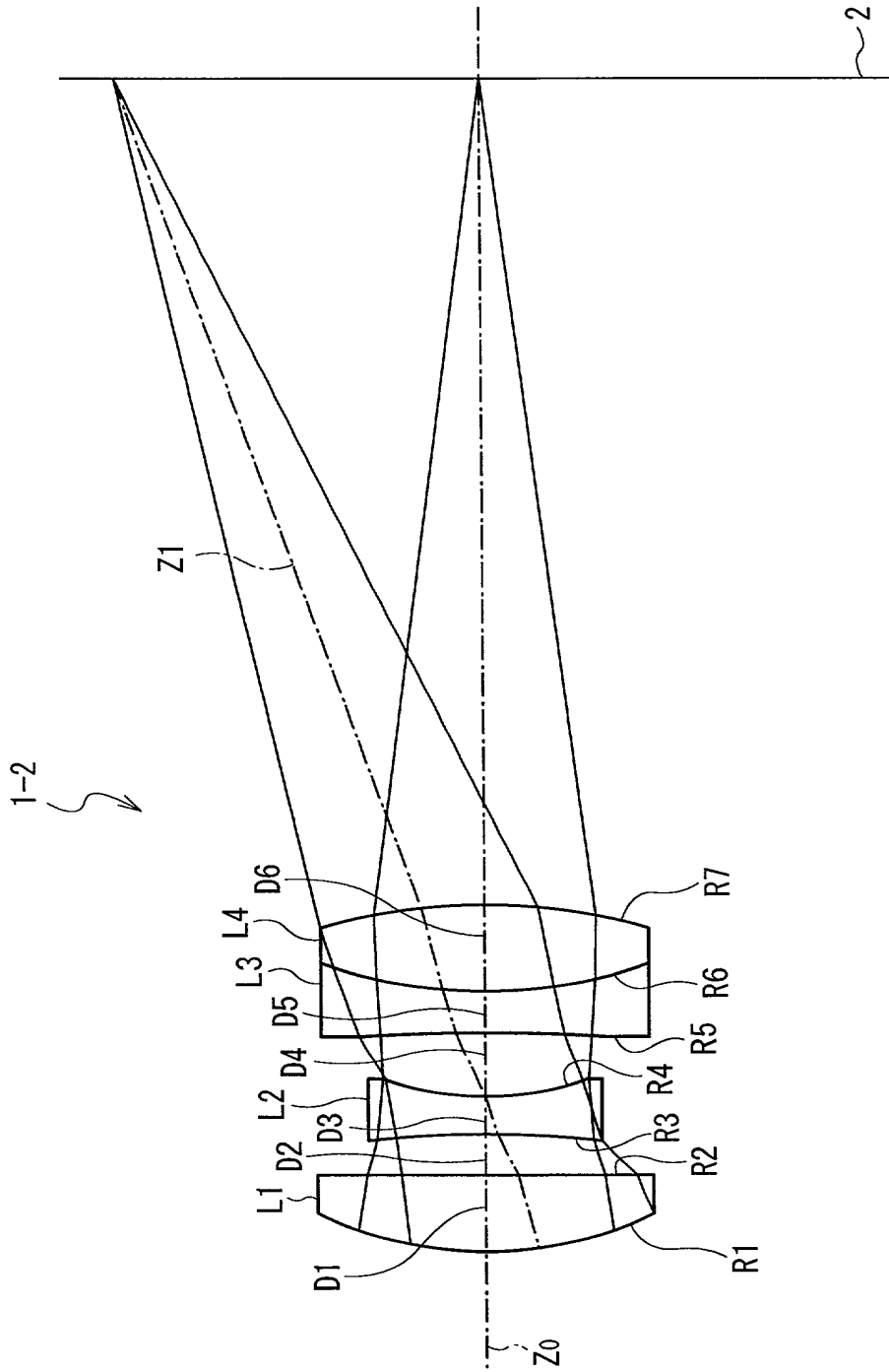


FIG. 22

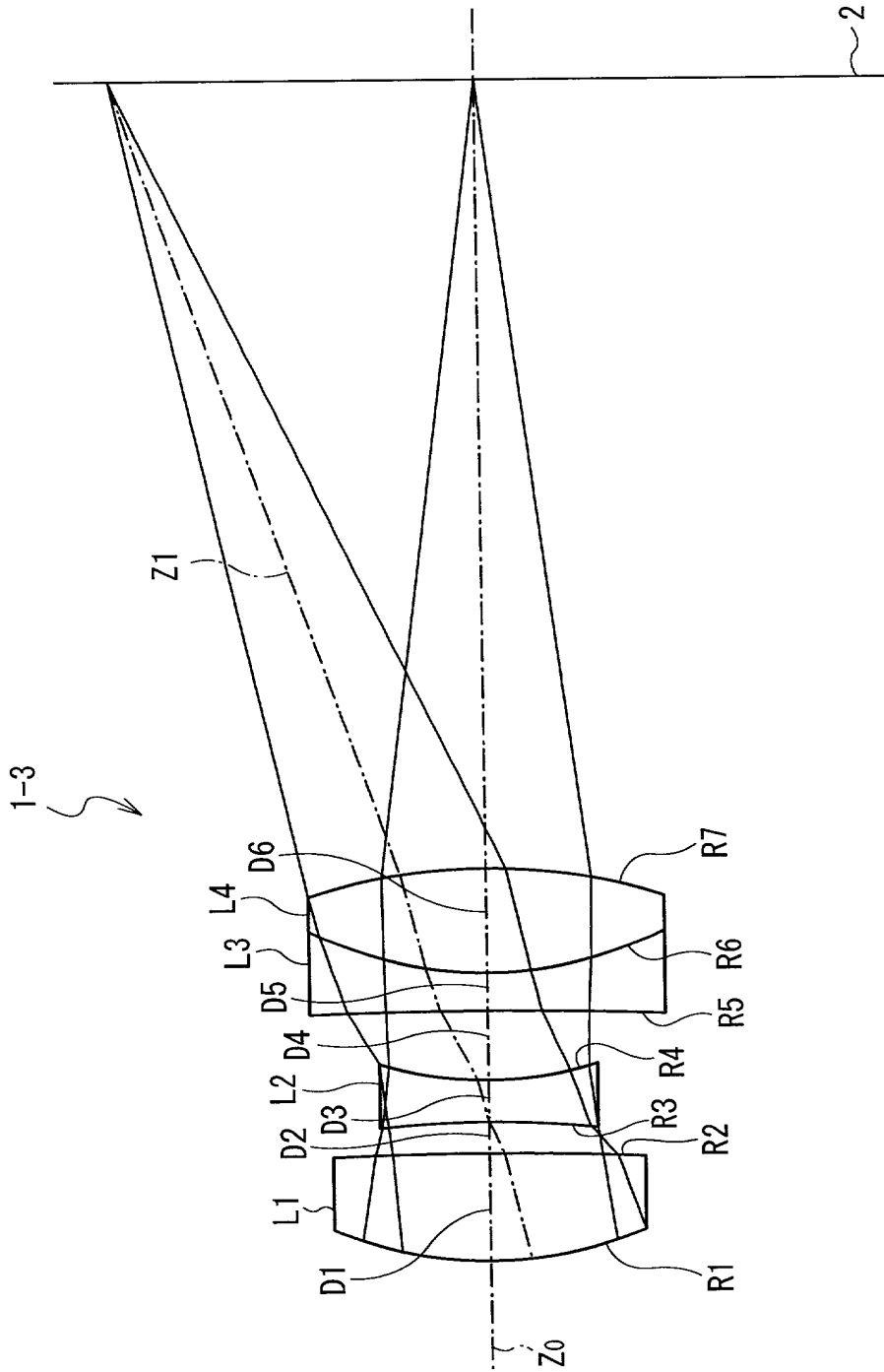


FIG. 23

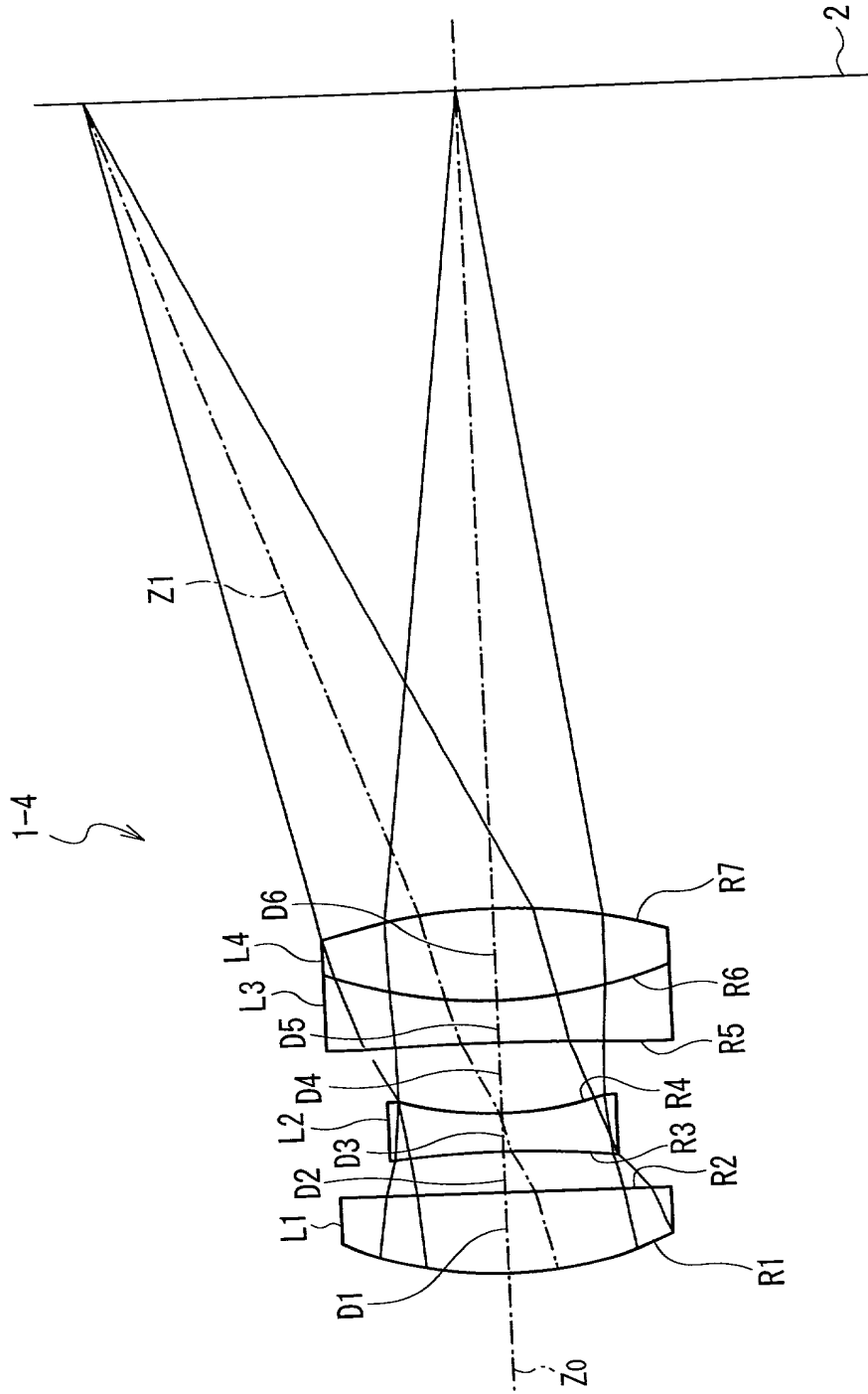


FIG. 24

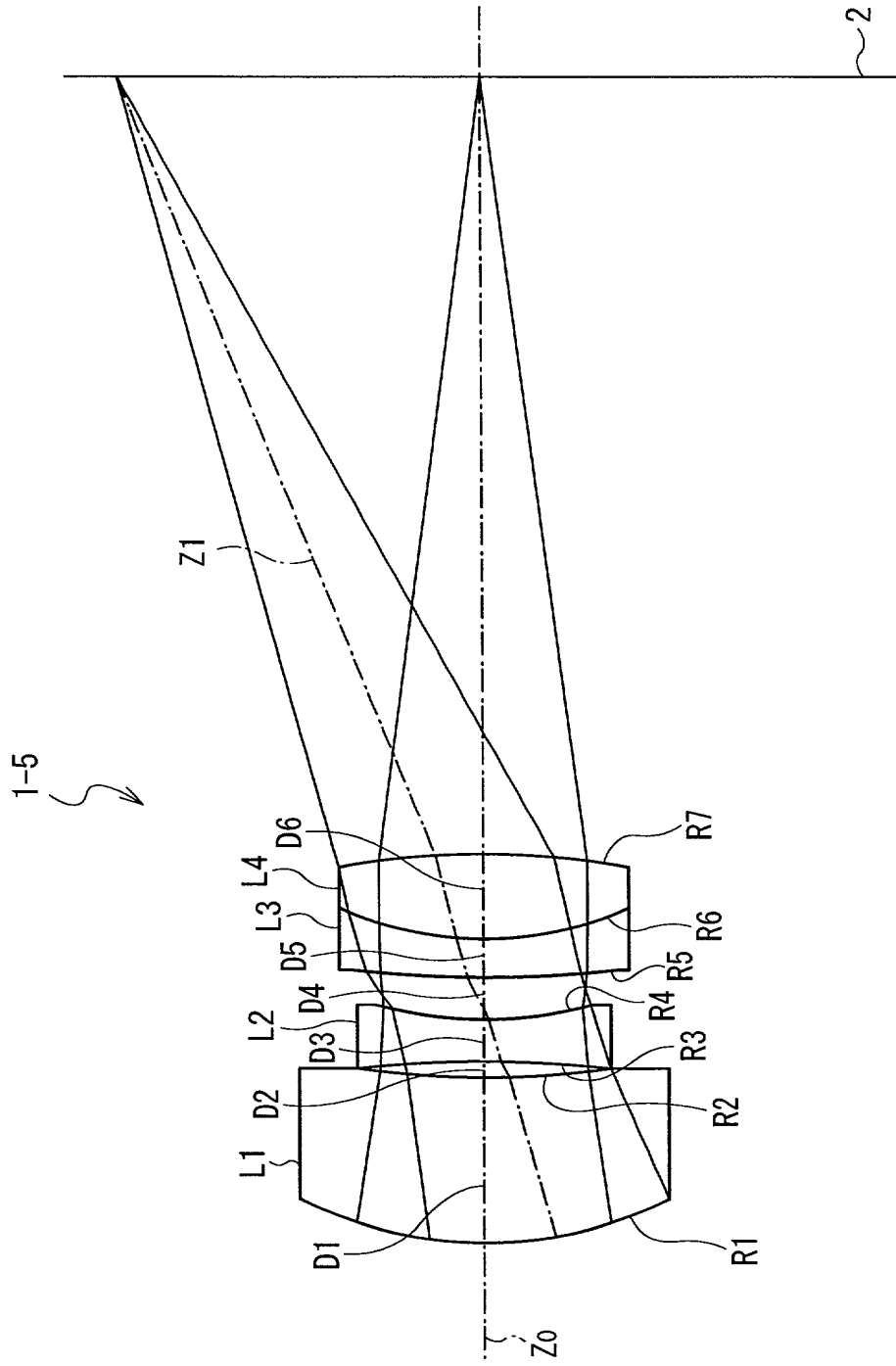


FIG. 25

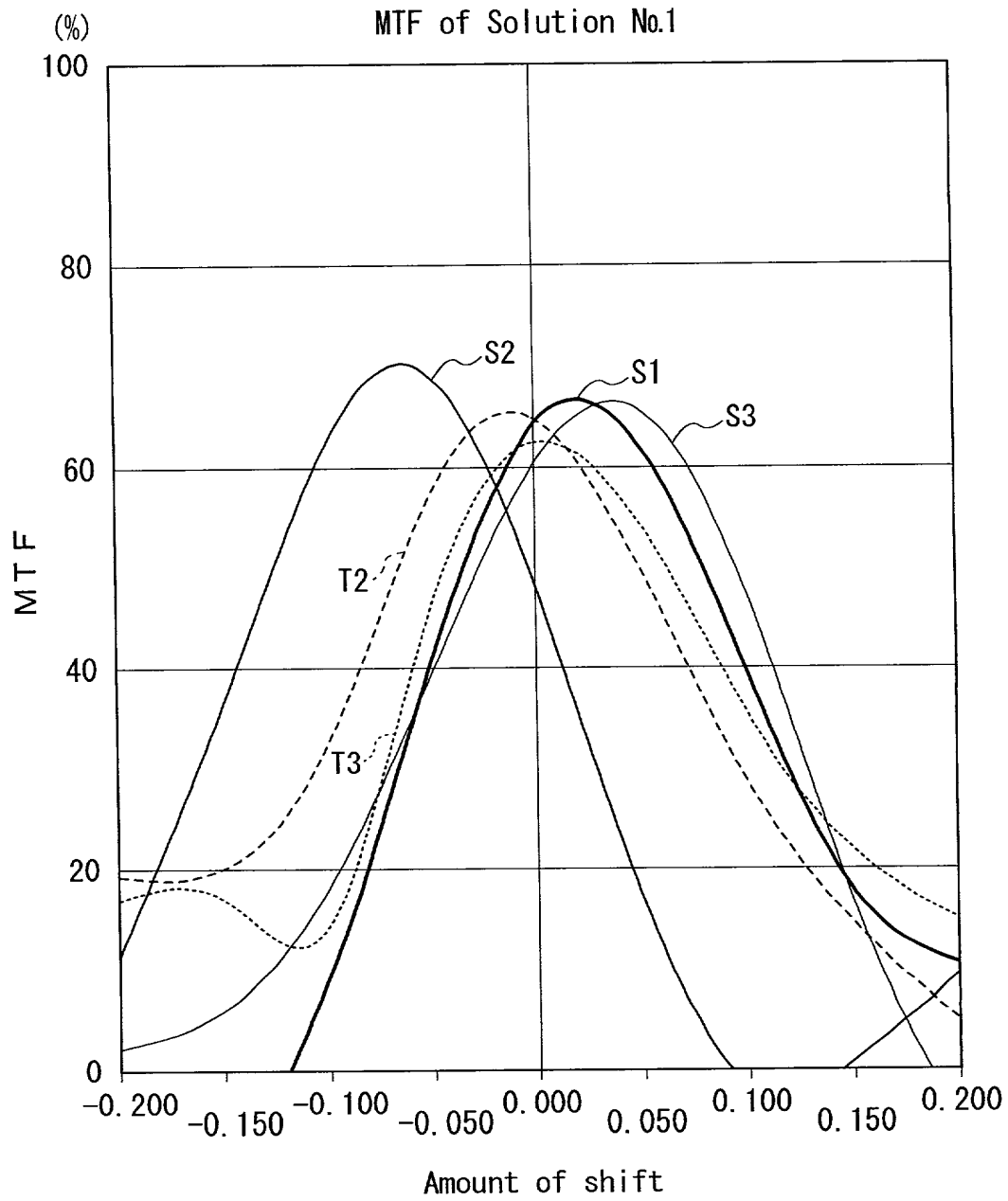


FIG. 26

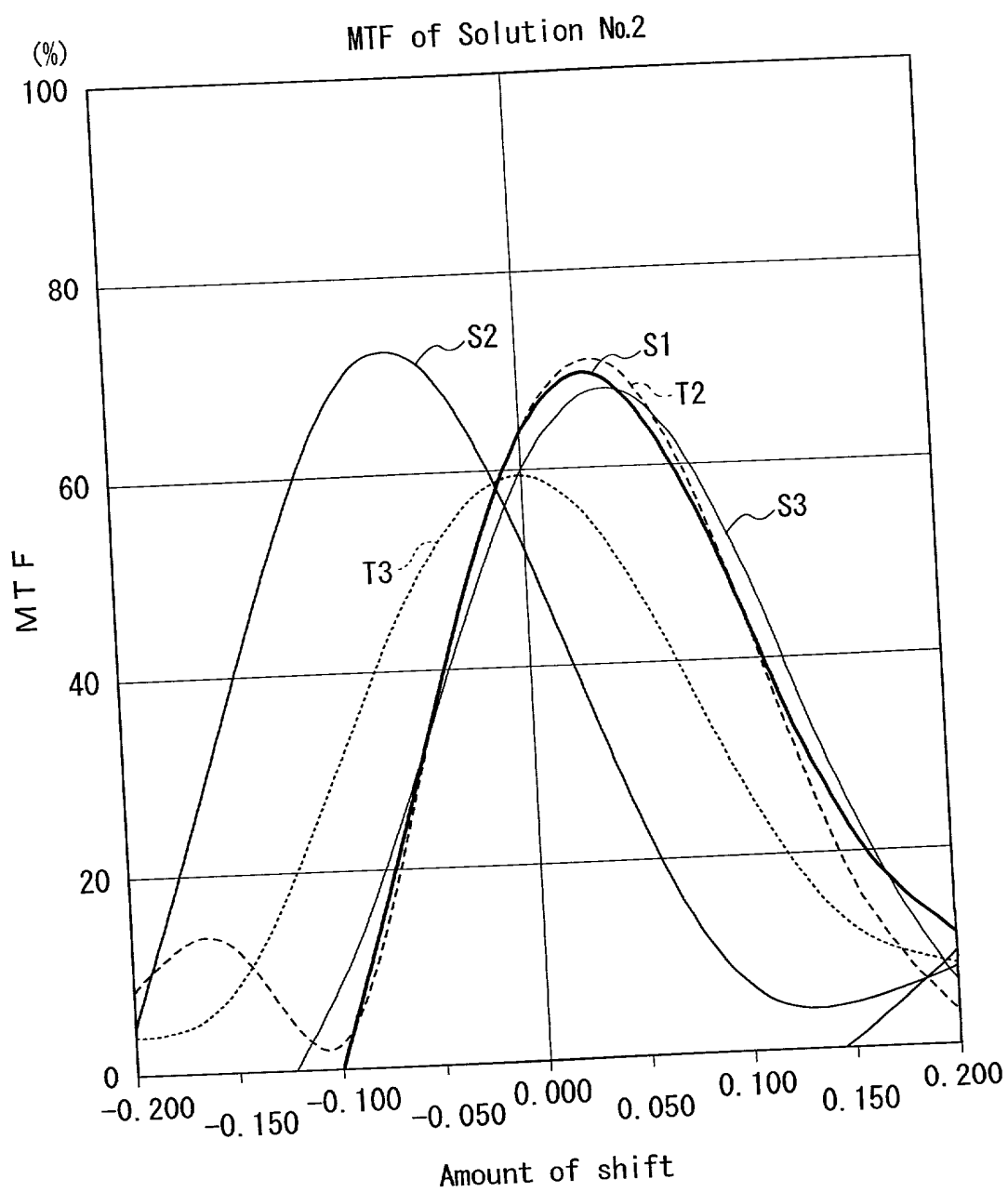


FIG. 27

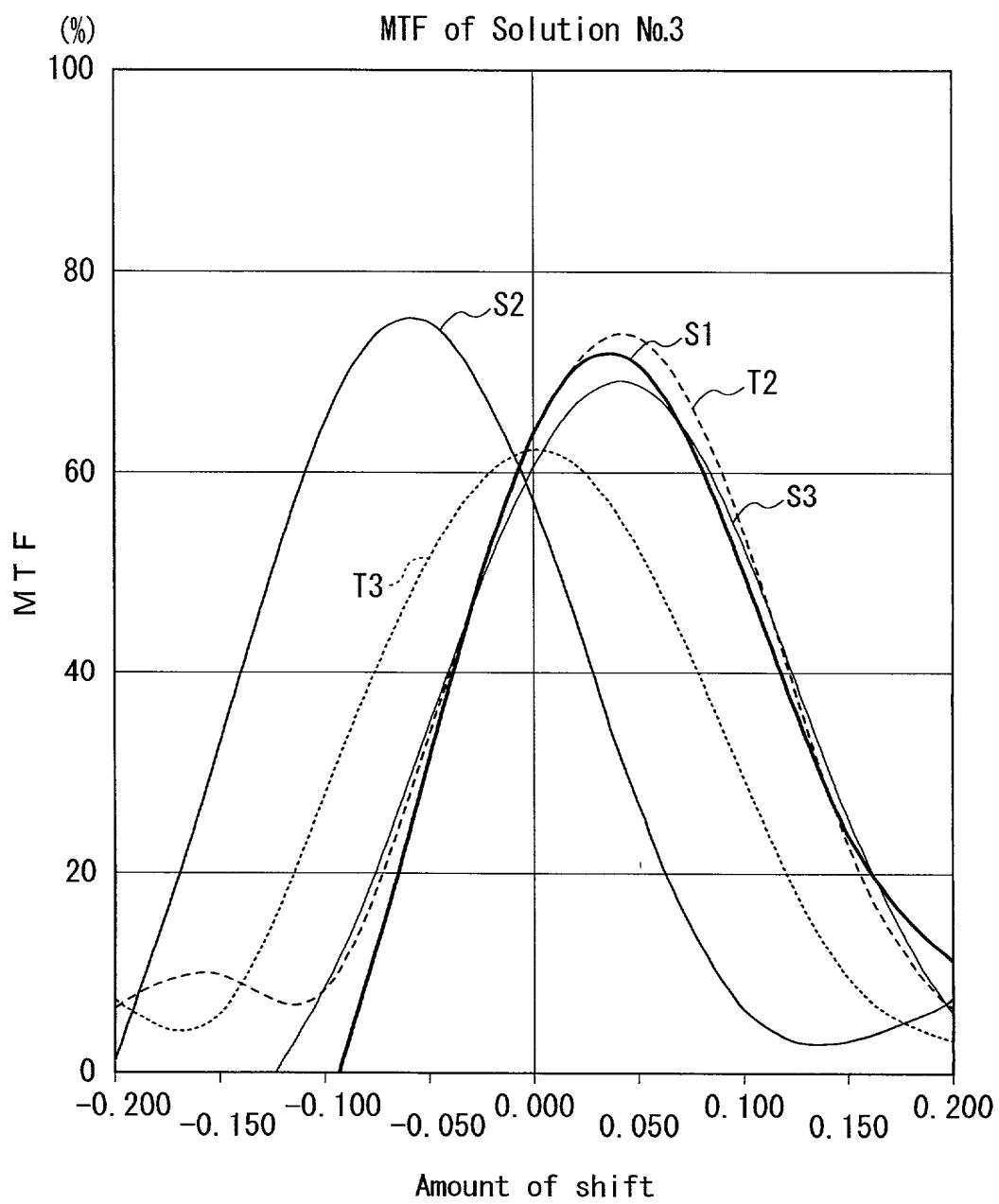


FIG. 28

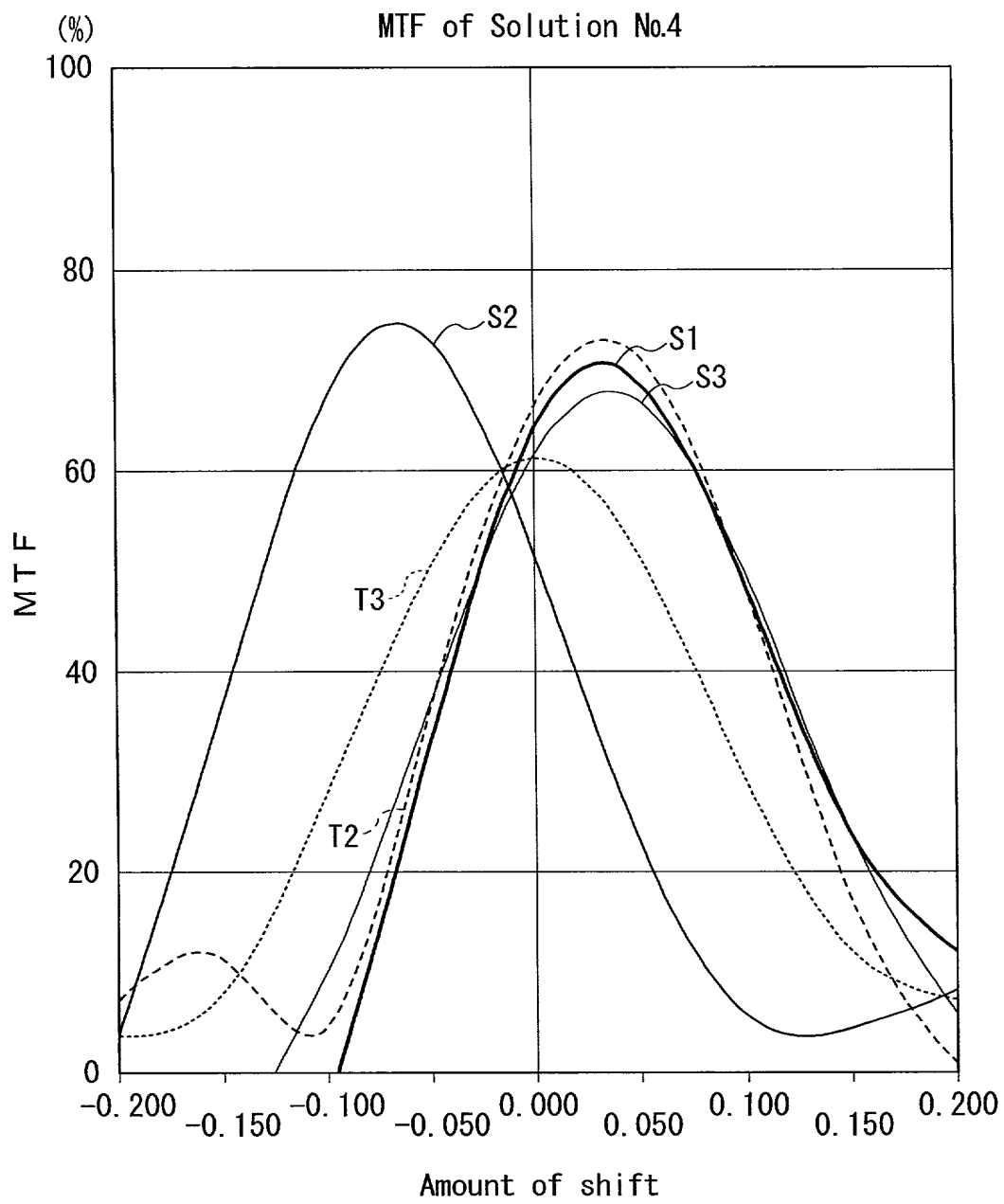


FIG. 29

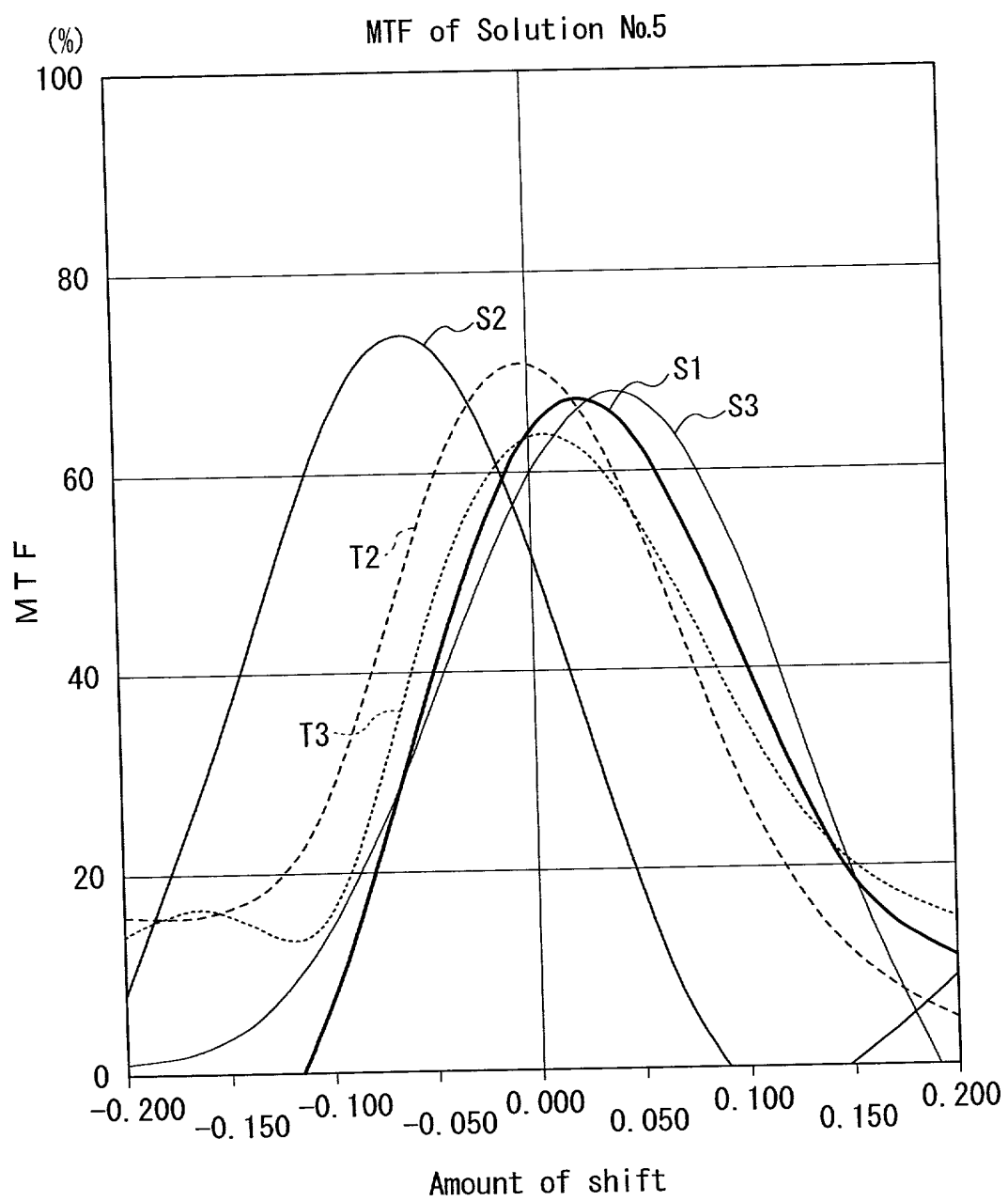


FIG. 30